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AFRICAN RURAL ECONOMY PROGRAM

WORKING PAPER

Farmers' Behavior Towards New Technology:
The Senegalese Case

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FARMERS' BEHAVIOR TOWARDS NEW TECHNOLOGY:

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AFRICAN RURAL ECONOMY PROGRAM

The African Rural Economy Program was established in 1976 as an activity of Michigan State University's Department of Agricultural Economics. The African Rural Economy Program is a successor to the African Rural Employment Research Network which functioned over the 1971-1976 period.

The primary mission of the African Rural Economy Program is to further comparative analysis of the development process in Africa with emphasis on both micro and macro level research on the rural economy. The research program is carried out by faculty and students in the Department of Agricultural Economics in cooperation with researchers in African universities and government agencies. Specific examples of on-going research are: "Income Distribution, and Technical Change in West Africa," "Rural and Urban Small-Scale Industry in sub-Saharan Africa," and "Farming and Marketing Systems Research in Tanzania, Kenya, Cameroun, Upper Volta, Senegal, Mali, and the Gambia."

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I. INTRODUCTION

The adoption of new technology in developing countries is an important issue today. Several studies have attempted to discover ways of encouraging the development and the adoption of new technology in these countries. But modern technology, according to Denis Goulet, [1968], is not neutral. It affects development in four ways:

> "It is a major source of creating new wealth; it is an instrument allowing owners to exercise social control in various forms; it decisively affects modes of decision-making; and it relates directly to patterns of alienation characteristic of affluent societies" (p. 25).

These characteristics of modern technology have led to the development of two distinct approaches to the transfer to technology to less developed countries. One emphasizes adapted technology and the other, intermediate technology. The adapted technology approach, as far as rural development in tropical Africa is concerned, advocates the tropicalization of modern technology, i.e., its adaptation to African natural, social and economic environments. It implies no necessary progression through stages of technological development. The proponents of intermediate technology, on the other hand, see it as a necessary transitory stage from traditional to modern technology. With respect to agricultural intensification and mechanization, they advocate the use of different combinations of animal power and mechanical equipment as the appropriate way to increase productivity in rural areas, while avoiding the proletarianization of the rural poor.

In Senegal, both these approaches are noticeable in rural development programs, but the intermediate technology approach dominates. This paper analyzes the behavior of Senegalese farmers towards this dominant approach to technology in the context of Senegalese pricing policies. It focuses on the situation prevailing in Thies, one of the older peanut basin regions.

The paper is divided into six parts. The first is a brief overview of the literature on the Senegalese farmers' behavior towards new technology. The second part analyzes the availability of factors of production and income, and their distribution among farmers in the peanut basin. In the third part we discuss the organization of production at the farm level and in the fourth part, the pricing system of labor in the peanut basin. The fifth part analyzes the profitability of various intermediate technological packages proposed to farmers in the peanut basin which are intended to enable them to intensify their farming. In this part we compute benefit/cost ratios of the different technical packages under conditions prevailing in Thies. A complete farm budget for each input has been computed. Finally, the last part of this paper points out the need to consider carefully the internal wage system at the farm level when dealing with technological change in farming practices in developing countries.

II. RELATED LITERATURE AND RESEARCH

One of the earliest challenges to the use of intermediate technology to promote technical progress and social equality in rural areas of Senegal was Brothier [1975]. In his "The Diffusion of Technical Progress in Rural Senegal," he focused on the methodology used by Extension Boards in promoting technical progress. For him, the "policy of modernization based on individual farmers . . . strengthens inequalities and tensions;" while "technicians focusing on individual farmers reinforce unegaliterian tendencies . . ." [p. 240]. He suggested that the extension services work with farmers in groups rather than as individuals.

R. Tourte [1965] sharply criticized Brothier's approach at that time. He wrote:

> "Brothier has expressed his concern . . . about the disequilbrium that a too personalized extension would bring out in the milieu . . . This danger is real. But it is inevitable to some extent. While it may be necessary to avoid the "kulakinzation" of Senegalese agriculture, it would not be better to maintain non-viable (too small) farms . . . Technical progress in some overpopulated regions will be at the expense of these little farms."[1]

For Tourte, inequality is inevitable and one must promote rural exodus from overpopulated to underpopulated zones. Technical progress will find its way, slowly but surely.

The promotion of this intra-rural exodus has led to new settlements in the Eastern Senegal region and the creation of the Societe de Terres Neuves, or S.T.N., to promote settlements in the new peanut basin. The S.T.N. was technically sponsored by ORSTOM.[2] But ORSTOM's own research has shown that soon after the beginning of a new settlement, farmers spontaneously reproduce their traditional organization

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[1]R. Tourte, "Au sujet de << la diffusion du progres technique en milieu rural Senegalais >> du Dr. Brothier." (Bambey, 1965.)

[2]ORSTROM: A French extension and research agricultural institution; it sponsored S.T.N. until 1975.

of labor and have the same division of cash crop and food crop production as they had in the old peanut basin. Indeed, tensions within the new family compound are more acute than ever, and have led to a widespread failure to comply with the terms of the settlement scheme. In Diagle Sine,[1] for example, ORSTROM's 1974 annual report indicated that 20 percent of peanut plots were in the wind-break; 13 Navetanes (hired laborers) had changed family compounds at least once while four had changed twice. In effect, the same problems with agricultural labor that were encountered in the old peanut basin have arisen in the new settlements as well. Overpopulation of the new settled villages has become a problem and has led to a paradoxical situation: in 1976-77, states the annual 1977 S.T.N. report, among 294 new farmers, 198 were from the recently established villages, and the remainder from the old peanut basin. Instead of facilitating the adoption of intermediate technology by farmers, the intra-rural exodus approach has extended the problems of the old peanut basin to the new peanut basin.

This situation has led Jean-Claude Rouveyran [1972] to question the rationality of farmers' behavior towards new technology. He argues that the key to the non capital intensive orientation of farmers in developing countries is the mentality of traditional farmers. Reasoning that this mentality of the traditional farmer is linked to his conception of time, he wrote: "In Western societies, time is lived . . . in traditional societies, time is repetitive; that is, a high rate of discount is applied to the farmer's computation of return." He further states that . . . "this mentality is the opposite of the spirit of enterprise because the idea of investment requires a sufficient conceptualization of the time dimension . . ." Moreover, this kind of mentality does not promote savings and their profitable use. The farmer feels comfortable within the transitory system, and he . . . "hopes to maintain it with its composite advantages[2] . . ." Thus, he concludes, the traditional farmer has

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[1]Diagle Sine: A village of new settlement.

[2]Jean-Claude Rouveyran, "La logigue des agriculteurs de transition." (G.P. Maison Nevve et Larose, Eds., 1972), pp. 114 and 150 respectively.

a negative attitude towards development.

Researchers working mostly in the Anglophone countries suggest other factors which may influence farmers' behavior towards new technology. Collinson [1972] outlines four needs which dominate decision-making and resource allocation in traditional Africa, namely: (1) quantity of food, (2) nutritional quality, (3) reliability of supply, and (4) preferred taste for particular seasonal periods throughout the cropping year. For example, planting time may be staggered so as to assure that harvest will coincide with particular cash requirements, i.e., school fees, village ceremonies, or to fulfill a particular nutritional gap at the end of the dry season.

In a study of three villages in Zaria region of northern Nigeria, D.W. Norman [1973] incorporates risk in his consideration of farm resource allocation with respect to two alternative goals: profit maximization and security. Norman shows that farmers allow for risk through (a) intercropping, a form crop diversification; (b) locating food crop mixtures closer to residential areas, consequently receiving greater attention than cash crops planted further away; and (c) changing their degree of market orientation.

In summary, we have seen that factors which influence the farmers' adoption of new technology are thought to be both exogenous and endogenous. The exogenous factors are (a) methodological (personalized and individualized approach in extension work), and (b) political (attempt to maintain non viable farms). The endogenous factors are thought to be (a) psychological (the farmers' mentality), and (b) motivational (food security and profit maximization). However, in Senegal, two endogenous institutional factors -- the organization of production at the farm level and the internal wage system within the household -- probably play a more decisive role in the farmers' behavior towards new technology than the above mentioned factors. In this paper we will focus our attention on these two institutional factors.

III. FACTORS OF PRODUCTION AND INCOME

Several studies have shown that among farmers in rural Senegal a great heterogeneity exists with respect to available resources and income distribution. This heterogeneity is based mainly upon the availability and distribution of equipment and cultivated land.

A. The Availability of Equipment and Its Distribution

1. Types of Equipment

The characteristics of the mechanical tools employed by Senegalese farmers in the peanut basin are given in Table 1.

TABLE 1

DESCRIPTION OF TECHNICAL EQUIPMENT EMPLOYED IN THE PEANUT BASIN

Types of Tools	Power Source	Job Performed	Working Width
Occidental Cultivator (Houe Occidentale)	Donkey, horse or oxen	weeding	.45 - .60m
Sine cultivator (Houe Sine)	Donkey, horse or oxen	weeding	.60m
Greco cultivator (Houe greco)	Oxen	weeding	.60 - .90m
Arara	Oxen	weeding and plowing	.90m
Ariana	Oxen	weeding and plowing	.90m
Polyculteur	Oxen	weeding, plowing and sowing	1.80m

The results of a rural census carried out by Albenque [1974] in 1973 in the Experimental Units of the Senegalese Agricultural Research Center (CNRA) yielded the following results:

1. Eleven percent of all family compounds in the sample do not own a seeder;
   Fifty-eight percent own one seeder,
   Twenty percent own two, and
   Ten percent own three or more.

2. Thirty-five percent of all family compounds in the sample do not own a sine cultivator;
   Fourty-eight percent own one,
   Fourteen percent own two, and three percent own three or more.

3. Fourty-five percent of all compounds do not own an occidental cultivator;
   Fourty percent own one,
   Nine percent own two, and
   Five percent own three or more.

4. Only 20 percent of all compounds in the sample own an Arara multiple purpose plow/draw bar.[1]

Thus, ownership of equipment among farmers in these areas is not equal and reflects the existence of heterogenous needs as well as unequal opportunities to produce.

Several combinations of equipment and animal power can be found throughout the peanut basin, particularly combinations such as horses with Arara and oxen with Ariana. However, the most typical combinations found by researchers and SODEVA[2] are the following:

(1) Labor package: family or hired labor + light fertilizer.

(2) Ariana package: pair of oxen + labor + heavy fertilizer + Ariana.

(3) Polyculteur package: pair of oxen + Polyculteur + labor + heavy fertilizer.

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[1] Figures about Ariana and Polycultuer were not available at the time this paper was completed.

[2] SODEVA refers to the Societe Pour le Developpement et le Vulgarization Agricole, a regional board charged with extension activities in the old peanut basin.

2. Adequacy of Equipment

Some studies have been carried out to measure how adequately the farmer is equipped, given his endowment of land. Adequacy in this sense is a parely technical measure defined as the ratio of the working capacity of a farmer's technical equipment over the amount of land cultivated by the farmer. When the adequacy ratio is close to 100 percent, the farmer is said to be well equipped; where it is far above 100 percent, the farmer is over-equipped; and when it is far below 100 percent, the farmer is said to be under-equipped. In practice, this ratio is used as a basis for making recommendations on equipment purchases to farmers.

Clearly, a measure of adequacy defined in this way bears little relationship to the economic least cost combination of factors (equipment, land and labor) for a particular farmer. This could explain why farmers are less and less willing to follow recommendations for technical change made by research and extension institutions in Senegal.

J.L. Newman [1973] demonstrates that the ratio between the capacity of a farmer's equipment and the amount of land he cultivates is, as a rule, very low for large farmers. This is evident from Table 2.

In a similar study Ramond and Fall [1976] have shown that on the average this ratio is very low for the center of the peanut basin. Their results are presented in Table 3. The authors also show that the average income per rural active is independent of the value of this ratio, though it is highly correlated with the <u>amount</u> of <u>cultivated land per rural active</u>. They found a simple correlation coefficient of .74 between the amount of cultivated land per rural active and average income per rural active in the area studied.

B. <u>The Distribution of Land</u>

In December 1976 SODEVA published its annual report on the agricultural program. In the report SODEVA divided farmers in the peanut basin into three money income strata: the lower 25 percent, a middle 50 percent, and the upper 25 percent.

TABLE 2

AVERAGE RATIO BETWEEN CAPACITY OF EQUIPMENT AND CULTIVATED LAND AMONG 170 PILOT FARMERS IN SINE SALOUM

	Area of Cultivated Land (in hectares)						
	< 8	8-12	12-16	16-20	20-24	24-32	32-44
Number of farmers	13	36	26	23	18	23	18
Units of sarclage*	2.5	2.6	3.0	3.3	2.8	5.3	6.3
Capacity of sarclage**	7.5	7.8	9.0	9.9	11.4	15.9	18.9
Equipment ratio***	94%	78%	64%	55%	52%	57%	50%

*A unit of sarclage is the working capacity of one occidental cultivator. Accordingly: 1 Sine cultivator = 1.5 units of sarclage
1 Arara = 1.5 units of sarclage
1 Ariana = 2.5 units of sarclage
1 Polyculteur = 3.5 units of sarclage.

**Capacity of sarclage is the number of units of sarclage times 3, since 1 unit of sarclage is sufficient to cover three hectares of land.

***This ratio equals the capacity of sarclage over the total cultivated land, using the mid-points of area categories for all but the first category. The first category uses 8--the upper extreme of the range.

Source: Newman [1973].

TABLE 3

RATIO BETWEEN CAPACITY OF EQUIPMENT AND CULTIVATED LAND IN THIES AND DIOURBEL (C/L)

Regions/Villages	Area of Cultivated Land (ha)		The C/L Ratio	
	Per Seeder	Per Cultivator	Seeder	Cultivator
Thies/Got	5.16	5.87	58%	51%
Diourbel/Ndiamsil	7.46	4.69	40%	66%
Diourbel/Layabe	9.36	8.97	32%	30%

Source: Raymond and Fall [1976].

TABLE 4

LAND DISTRIBUTION AMONG COOPERATIVE MEMBERS BY INCOME CLASS AND REGION

Regions	Proportion of Land Cultivated by Cooperative Members		
	Lower Income Strata (25% of Farmers)	Middle Income Strata (50% of Farmers)	Upper Income Strata (25% of Farmers)
Thies	11%	30%	45%
Diourbel	10%	28%	46%
Sine-Saloum	9%	26%	48%

Source: SODEVA (1976).

The distribution of cultivated land in the peanut basin according to this stratification is outlined in Table 4.

Obviously, land is concentrated in the hands of the 25 percent of the total cooperative members with the highest income. Such an unequal distribution of land, combined with the unequal distribution of equipment analyzed above, no doubt gives birth to an inequality in welfare if use of the equipment is, indeed, profitable.

C. The Distribution of Income From Peanuts

The same SODEVA report mentioned above gives a breakdown of the share of peanuts produced by cooperative members. That report indicates that 15 percent of the total cooperative members in Thies region, 14 percent of the members in Diourbel region, and 15 percent of those in Sine-Saloum region account for 50 percent of total peanut production respectively in each of those regions. Earlier, in 1971, R. Tourte [1971] reported that 55 percent of farmers in the peanut basin accounted for 25 percent of total peanut production, while 15 percent accounted for 30 percent of the total. Together these data show not only an unequal distribution in money income among farmers, but they show as well the growing economic power of the 15 percent of the Senegalese farmers whose share in total peanut production has grown from 30 percent in 1971 to 50 percent in 1976.[1]

The great heterogeneity in rural Senegalese society makes it necessary to divide compounds into relatively homogenous categories according to the amount of equipment and land they have and their share in total production. A first attempt at this in the peanut basin was made by Tourte [1971]. He divided farmers into three categories according to the degree of intensification. The first category defined by Tourte includes farmers with the lowest level of

[1]One might argue that the growing economic power of the largest 15% of Senegalese farmers is the result of better productivity of labor and equipment on their land, or of better quality of land and climatic conditions. However, there is little evidence supporting such an explanation. Easier access to land and labor seems to be the factor accounting for the difference.

intensification and was called "theme leger" (T.L.). These farmers use either labor alone or light animal power combined with the use of light or low analysis fertilizer. They represented 55 percent of the farmers in the peanut basin in 1971 and produced 25 percent of total peanut production. The second category, called "theme lourd" (T.B.), includes those who have begun to intensify their farm. Farmers in this group use oxen power and heavy or high analysis fertilizer. They represented 30 percent of the total farmers in the peanut basin 1971 and accounted for 45 percent of total peanut production. The third category includes those who use oxen power and heavy fertilizer, but who in addition have destumped and regularly plow a part of their land. These are called "intensive farmers" (T.B.F.F.). In 1971 these farmers represented 15 percent of the total number of farmers in the peanut basin and accounted for 30 percent of total peanut production.

The existence of these three broad categories of farmers in the Senegalese peanut basin and the gaps between them in land use, equipment and income requires a separate study of farmers' behavior in each category. Theoretically at least, the behavior of farmers in the least intensive category towards new technology will differ from the behavior of farmers in the more intensive categories. Before moving into such an analysis, however, we need to provide additional background information on the organization of labor and the wage system within rural households in Senegal.

IV. ORGANIZATION OF LABOR

Several studies have been undertaken in the peanut basin which describe the organization of labor at the farm level. Monier [1974] and Albenque [1974] have shown that production at the farm level is organized by the chef de carre or chief of the family compound. The chef de carre uses the labor of the members of the family on his own cash crop plot as well as in the family food crop plot. In exchange for the use of this labor, he must feed them and allocate to them a piece of land where they may grow cash crops for their own account.

Thus, within the family compound Monier [1974] distinguishes the following social strata: (1) chef de carre; (2) wife; (3) surga and (4) navetane. The surga is a direct (his own) or indirect (his wife's) relative of the chef de carre. When the surga is married he can be dependent or independent. The dependent surga has the same labor relationship with the chef de carre as before his marriage, while the independent married surga has no, or a negligible, labor relationship with him. The navetane, on the other hand, is not a relative of the chef de carre. He is a hired seasonal laborer. In a family compound the chef de carre and the independent married surga (if any) are the decision-makers.

This kind of labor organization is reproduced over time through beru (separation). In beru the married surga leaves the family compound and organizes his own compound using surga and navetane as was done in the family compound he left. This kind of labor organization and its reproduction occurs everywhere in both the old peanut basin and the new peanut basin (southern Sine-Saloum and areas of new settlement in the Eastern Senegal Region). Moreover, Richard [1975] has shown that this organization of labor is found in all categories of farmers in the peanut basin from theme leger to T.B.F.F., or intensive-farmers.

Within this system of labor organization the chef de carre cultivates half of the available land and the other half is distributed to the other members of the family compound. A portion of the half for other members of the family may be used by the chef de carre to hire labor (navetane) if needed. The amount of household land given to surga or required to hire a navetane varies by region and averages around .40 hectare in Thies and Diourbel, .80 hectare in Bambey, and 1 hectare in the southern Sine-Saloum and the Eastern Senegal Region (regions of new settlement).

The chef de carre divides his own field into two equal parts: one half of food crops and one half for cash crops. All members of the family compound work on his fields from morning to mid-afternoon. The remaining time they work on their own plots. It is not surprising, therefore, that Ramond and Fall [1975] found a positive relationship between the amount of cultivated land and the population of a compound in Bambey and Diourbel. Moreover, the number of rural actives in a compound and the amount of cultivated land are positively related as well. J.L. Newman [1973] has shown the same tendency for the so-called "pilot peasants" in Sine-Saloum.

When land becomes scarce for large compounds, holdings become scrambled and surga are transformed into navetane. This process is taking place in Thies and Diourbel as Ramond and Fall [1975] have shown. In Ndiamsil Sessene in Thies Region, for example, 53 percent of plots are between 0 and .5 hectare. In spite of the small size of plots, the average rural active cultivates 3 hectares for the head of the family compound in Diourbel and 2 hectares in Thies, Bambey and Sine-Saloum.

So far, we can draw the following conclusions with respect to Senegalese farmers' behavior towards new technology: the intensity to technology is correlated with social differentiation among farmers, while at the same time, traditional labor organization and labor intensive technologies have persisted even on those farms technically more advanced. Other important findings include: (1) the existence of a positive relationship between the number of rural actives and the amount of cultivated land, (2) a positive correlation between income and the amount of cultivated land per active, and (3) the existence of absolute (average) and relative (by size) underequipment.

V. WAGE SYSTEM

The price of human labor (rural active) is pretty much the same for all the categories of farmers within a region, but varies from region to region because of a change in the amount of land allocated to navetane and surga in exchange for their labor. This allocation varies, as we have seen, from .4 hectare in Thies and Diourbel to 1 hectare in southern Sine-Saloum and the Eastern Senegal Region. In addition, soil fertility is better and population densities are lower where land allocations are higher. Obviously, the greater the productivity of a rural active because of the fertility of the soil, the higher the opportunity cost of the land given up by the farmer for the use of this kind of labor. Moreover, it is clear that real wages for agricultural laborers are much higher in southern Sine-Saloum than in Thies. If the agricultural labor market in rural Africa is perfect, as is often claimed, laborers should react positively to this wage differential (land allocation and yield per hectare in Sine-Saloum almost twice as much as in Thies) by moving to Sine-Saloum. However, the widespread presence of agricultural laborers in Thies suggests that this is not occurring.

Several factors appear to explain this apparent rigidity. First of all, the navetane, or non-family laborers, are indeed moving from Thies/Diourbel toward Sine-Saloum and the Eastern Senegal Region. Surga, on the other hand, have familial as well as economic ties to the household production unit. Though receiving an effective wage in the form of food and land they do not interpret their relationship with the chef de carre as one of wage laborer. Rather, family members see their first duty as one to stay and work in the family household for as long as they are not married.

It is not surprising that this conception of the family labor responsibilities is consistent with the economic interest of the head of the family compound, and is taught to family members from childhood. However, economic pressure (increasing cost of food, scarcity of land in terms in quantity and quality), demographic pressure and lack of alternative jobs in the neighborhood are making even family labor less and less hesitant to migrate to Sine-Saloum and to Eastern Senegal Region where real wages are much higher.

There is, in studies of peasant farmers, a tendency to ignore the cost of family labor to the household, and to treat the household as a single unit of production. It is frequently assumed that the only household labor costs are those paid to outside laborers or seasonal workers. When the cost of family labor is computed it is often shadow priced at its average product.

Equating the wage of family labor to its average product assumes that the family divides its total product among family members. However, this point of view is more an inference from what is observed in towns than a reflection of what is going on in the village. In town, the head of the household, or simply the supporter of the family, shares his earned income with the family as a whole without requiring any labor counterpart. Usually he works outside of the home or he is running his own business and does not need extra help.

The situation is different in rural areas, as is suggested by two facts: the organization of labor within the household and the grain market that exists within the family. As we have already seen, the head of the household pays a wage to each household laborer by allocating him a given portion of land (where a cash crop is grown for the member's own income) and food. The revenue from the cash crop each member cultivates for himself depends on the amount of land he got from the head of the household in exchange for the use of his labor, the natural fertility of the land, and the technological intensity employed, which, as a rule, is different from that used by the head of the household.

This difference in technological intensity prevails because some members of the household (women, non-married surga and dependent married surga) are not eligible for membership in the cooperative, the sole source of institutional credit for variable and capital inputs. Furthermore, the internal division of labor requires that priority be given to the plots of the head, making other household members residual claimants should the head of the household be willing to loan his equipment to them.

The actual amount of land a family member in a given region gets depends on the total availability of land for the household, the sex and age division of family labor and the relative bargaining power of the family labor with respect to the head of the household. In such a world, it is hard to believe that the appropriate wage for family labor is simply an average of the family's total product.

Evidence of the existence of grain market within the household reinforces this view. The importance of this grain market with respect to other grain markets is demonstrated by Yaciuk and Yacuik, [1971]. They present the following table from a sample of people who have sold grain, noting to whom they have sold it.

TABLE 5

TYPES OF GRAIN SOLD TO VARIOUS MARKET PARTICIPANTS

Grain Sold \ Category of Buyer	Number of Sales			
	ONCAD*	Local Market	Merchant	Father
Millet	115	73	34	60
Sorghum	15	22	13	28
Rice	43	5	21	25
Corn	11	4	13	36
Peanuts	559	6	1	3

Source: Yaciuk and Yaciuk [1971].

*National Marketing Board.

The most striking feature of this table is the relative importance of the food grain market within the household. The number of people selling food grain to the head of the family household is greater than the number of people selling grain to the local market or to merchants for all categories of food grain except for millet. Still, the number of people selling millet to the head of the family is greater than those selling to merchants.

Is this internal food grain market compatible with the well established belief of the role of the head of the household? Why should he buy food grain from the members of the household? Clearly it is not just due to kindness or a sense of responsibility towards the members of his family. This internal market can be understood only in the context of the internal wage system described above. The head of the household buys food grain from the members of the family because he needs the grain as a constituent part of the wage he pays them in exchange for their labor on his own plot.

VI. FARM BUDGET ANALYSIS

Having presented necessary background materials in Sections II-V, we proceed in this section to analyze the profitability of several actual and recommended technological packages available to farmers. Each technological package consists of various combinations of labor, fertilizer, oxen and equipment representing the three levels of technology - the theme leger, the theme lourde, and the intensive farmers, or T.B.F.F. discussed in Section III. In addition, the field capacities (and consequently cost per hectare) of various technologies vary according to whether actual farmers' practices or extension service recommendations are used. Differences in recommended and actual practices with respect to the care and sale of oxen are also incorporated, as are wage differentials for labor costs associated with the higher technology packages. The actual combinations analyzed, in order of increasing capital intensity, are as follows:

(1) Labor package (L): actual practices with respect to field capacity and use of "light" fertilizer.

(2) Ariana Package (AR):
- (A) Recommended practices with respect to rates of use and oxen feeding and sales.
- (B) Actual practices with respect to rates of use and oxen feeding and sales.
- (C) Recommended practices as in (A), but with a 15 percent wage differential to reflect the more exhausting and tedious work associated with this technology.

(3) Polyculteur package (POL):
- (A) Recommended practices with respect to rates of use and oxen feeding and sales.
- (B) Actual practices with respect to rates of use and oxen feeding and sales.
- (C) Recommended practices as in (A), but with a 30 percent wage differential to reflect the more exhausting and tedious work associated with this technology.

After constructing separate capital budgets for the oxen and technology alternatives we annualized the costs of each, added labor and fertilizer inputs per hectare, and assumed the relevant field capacity to arrive at average annual costs. These are then divided into average annual benefits calculated on the assumption that the technology is used one-half on millet and one-half on peanuts. This generates a benefit cost ratio per hectare of land which serves as the basis of comparison for the technological alternatives.

A. Capital Budgets

1. Budget for Oxen

The extension service recommends that farmers keep and use their oxen on the farm for five years before selling them and buying a new pair. We refer to this recommended alternative as alternative (A). A second alternative, referred to as alternative (B), reflects what farmers do in the real world: fattening the oxen and selling them after three years, then buying a new pair on credit. Farmers doing this generally feed the oxen with the grain supplement (1.5 kg. per head per day) in addition to the normal ration of peanut hay (8 kg. per head per day).

The salvage price of the pair of oxen varies according to their weight and the market period when they are sold. In this analysis a salvage price of 190,000 FCFA is used for alternative (A) and 160,000 FCFA for alternative (B). This difference reflects primarily differences in weight between animals used and fed for five years versus three years.

The cost of feeding the oxen each year is given by the following formula:

A) peanut hay

kgs./head/day	x	days of a year	x	price of 1 kg. of peanut hay	x	number of oxen
8		360		5		2

= 28,800 FCFA

B) grain/mineral supplement

kgs./head/day	x	days of a year	x	price of 1 kg. of grain/ mineral sup- plement	x	number of oxen
1.5		360		20		2

= 21,600 FCFA

The oxen and equipment are obtained on credit and repaid in five equal annual installments at the end of the crop year. Feed and repair costs must be paid by the farmer from his own capital. The cost per year of a pair of oxen under these two hypotheses, appropriately rounded, are given in Table 6. The details of the budgets are in Appendicies 1 and 2.

2. Budget for Polyculteur

The polyculteur costs 211,275 FCFA and has a salvage value of 30,000 FCFA. It too is purchased on credit and repaid during the first five years in equal installments. Farmers do not pay for repairs during the first five years unless a large capital repair is involved. However, from year five onward farmers must pay for repairs from their own capital. Table 7 summarizes the budget detailed in Appendix 3.

3. Budget for Ariana

The assumptions are the same here as for the polyculteur, except that the acquisition price of Ariana is 49,140 FCFA and its salvage value after 10 years is 4,500 FCFA. Budget details are contained in Appendix 4, and are summarized in Table 8.

B. Basis of Computing Costs and Benefits of Alternative Technological Packages

Differences between recommended and actual costs for the AR and POL packages arise from different assumptions about recommended versus actual area cultivated by the equipment. Again, alternative (A)

TABLE 6

AVERAGE ANNUAL COST OF A PAIR OF OXEN UNDER ALTERNATIVE ASSUMPTIONS REGARDING TIME HELD AND FEEDING PRACTICES

Description	Average Annual Cost Under Alternative (FCFA) (A)	(B)
Oxen depreciation	-29,000	-38,330
Oxen equipment depreciation	500	500
Repairs	500	500
Feed: Peanut hay	28,800	28,800
Grain	21,600	21,600
Opportunity cost of capital investment (15%)	14,440	10,250
Opportunity cost of working capital (15%)	3,820	3,820
Average annual cost	40,660	27,140

TABLE 7

AVERAGE ANNUAL COST OF POLYCULTEUR

Description	Amount (FCFA)
Equipment depreciation	18,130
Opportunity cost of investment (15%)	10,170
Repairs	2,500
Opportunity cost of working capital (15%)	190
Average annual cost	30,990

TABLE 8

AVERAGE ANNUAL COST OF ARIANA
(FCFA)

Description	Amount
Equipment depreciation	4,460
Opportunity cost of investment (15%)	2,180
Repairs	150
Opportunity cost of working capital (15%)	10
Average annual cost	6,800

describes the situation when each technical package is used as recommended. For example, the POL package is composed of a polyculteur, a pair of oxen, two laborers and fertilizer. The polyculteur, the pair of oxen and the two laborers should be used for 10.5 hectares, the working capacity of the polyculteur. Similarly, when Ariana package is adopted, the pair of oxen and 1.5 laborers should be used for 7.5 hectares, the working capacity of the Ariana.

Alternative (B) reflects the actual practices of farmers, i.e. the actual area over which the technical packages in each technical level are used. The SODEVA report of 1976 has shown that in Thies, the average farmer using the POL package cultivates 12 hectares. However, the POL package is used on only 4 hectares. On the remaining 8 hectares farmers use the labor package. Similarly, each farmer using the AR package cultivates 9 hectares, using the AR package on 3 hectares, and the labor package on the remaining 6 hectares. Thus, under this hypothesis the cost of the POL package is divided by 4 (instead of 10.5) and the cost of the AR package by 3 (instead of 7.5) to arrive at per hectare cost for each. This means that the per hectare labor cost is the same in all three packages, and is 1/2 laborer per hectare: for the POL package 2 laborers are required for 4 hectares; for the AR package 1.5 laborers are required for 3 hectares; and for the labor package 1 laborer is required for 2 hectares.

Alternative (C) maintains the same assumption as alternative (A), except that labor costs are increased by 15 percent for the Ariana and 30 percent for the polyculteur packages respectively in arriving at per hectare costs for these technologies.

C. Labor and Fertilizer Inputs and Output Prices

Table 9 summarizes labor inputs and fertilizer application rates for the various technological packages.

Table 10 sets out the yield assumptions used in our calculation. These yields represent performance in a normal rainy season. Production of millet can be as low as 320 kg./ha. in a bad year on a traditional farm, and can be as high as 1,800 kg./ha. in an exceptionally good year on a better equipped farm. Similarly, production of peanuts can be as low as 500 kg./ha. in bad years, and can be as high as 2,000 kg./ha. in exceptionally good years on better equipped farms. The yields employed should be considered average estimates only.

TABLE 9

LABOR INPUTS, FIELD COVERAGE AND FERTILIZER APPLICATION RATES ASSUMED FOR THREE TECHNOLOGICAL PACKAGES IN THIES REGION

Technological Packages	Number of Laborers Required	Areas Cultivated Under Alternatives (ha)		Fertilizer Applied (kgs/ha)
		(A & C)	(B)	
Labor	1	2	2	51
Ariana	1.5	7.5	3	53*
Polyculteur	2	10.5	4	148*

*Heavy fertilizer is a higher analysis material than that used with the labor package.

TABLE 10

YIELDS ASSUMED FOR MILLET AND PEANUTS FOR THREE TECHNOLOGICAL PACKAGES IN THIES

Technical Packages	Output/ha Millet (kg)	Peanuts (kg)
Labor package	550	750
AR package	760	885
POL package	1,150	1,250

In addition, the following prices for peanuts, millet and fertilizer were used in the analysis:

millet = 30 FCFA/kg.,

peanut = 41.5 FCFA/kg.,

fertilizer = 16 FCFA/kg., regardless of type.

These were the prices which prevailed during the 1976-77 growing season.

D. Cost of Labor Per Hectare

Under the prevailing wage system, the cost of labor to the *chef de carre* reduces to the opportunity cost of the foodstuffs fed to labor and the opportunity cost of the land given as a constituent part of the subsistance wage. For the *surga*, an appropriate cost of labor would need to allow for the cost of feeding the surga during childhood as well as for the entire year once the person is old enough to work in the field. It would also need to be reduced by the fixed cost of a father's family obligations independent of whether or not a family member worked. Similarly, a value would have to be placed on other household services provided by working family members. In order to avoid this quagmire we use the opportunity cost of hiring one *navetane* as the marginal cost of an additional unit of labor for the household.

The cost of hiring a *navetane* reduces to the cost of feeding him for the four months of the year over which he normally works and resides with the chef de carre plus the value of the output forgone by the household on the land given to him, minus the cost of producing that output had the chef himself worked the land or hired a laborer at an equivalent cash wage. Assuming the navetane uses the labor package on the .4 hectares he receives in the Region of Thies, that he cultivates peanuts on his parcel, and that the cost of feeding him reduces to the value of 200 kilograms of millet on an annual basis -- all quite reasonable assumptions -- we can calculate the equivalent cash wage of a navetane as follows:

Land Given Navetane (ha)		Price of Peanuts (FCFA)		Yield Per Hectare With Labor Package (kg)		Cost Of Fertil-izer Per Hectare (FCFA)		Cost Of Labor Per Hectare (FCFA)	Cost Of Feeding Navetane For Four Months (FCFA)		Cost Of Labor For Two Hectares (FCFA)
.4	×	[(41.5	×	750)	-	816	-	x]	$\frac{200 \times 30}{3}$	=	2x

where x is the cost of labor per hectare and the capacity of one laborer with the labor package is two hectares. Solving for x, we get 5,885 FCFA as the cash equivalent cost of a navetane per hectare. Rounding to 6,000 FCFA we get 12,000 FCFA per agricultural season for one navetane.

Since the terms of employment per agricultural season for one navetane and the method of payment are the same regardless of the technology employed, we can calculate per hectare labor costs for the other technological packages as follows:

for the Ariana:

$$\text{Alternative (A)} = \frac{12{,}000 \text{ FCFA} \times 1.5}{7.5} = 2{,}400 \text{ FCFA/ha},$$

$$\text{Alternative (B)} = \frac{12{,}000 \text{ FCFA} \times 1.5}{3} = 6{,}000 \text{ FCFA/ha},$$

$$\text{Alternative (C)} = 2{,}400 \text{ FCFA} \times 1.15 = 2{,}760 \text{ FCFA/ha};$$

and for the polyculture:

$$\text{Alternative (A)} = \frac{12{,}000 \text{ FCFA} \times 2}{10.5} = 2{,}285 \text{ FCFA/ha},$$

$$\text{Alternative (B)} = \frac{12{,}000 \text{ FCFA} \times 2}{4} = 6{,}000 \text{ FCFA/ha},$$

$$\text{Alternative (C)} = 2{,}285 \times 1.30 = 2{,}970 \text{ FCFA/ha}.$$

E. Computation of Benefit/Cost Ratios

1. Costs and Benefits for the Labor Package

The costs of the labor package per hectare is calculated as follows:

Cost of labor (FCFA)		kilos of fertilizer		price of fertilizer (FCFA)		cost of labor package per hectare
[6,000	+	(51	×	16)]	=	6,816

The benefit of the labor package per hectare is given by the following:

Output of peanut/ha		Price of peanuts/kg		Output of millet/ha		Price of millet/kg		Benefit of labor package per hectare
[(750	×	41.5)	+	(550	×	30)]	× 1/2 =	23,813

The benefit/cost ratio is given by:

$$B/C\ (L) = \frac{23{,}813}{6{,}816} = 3.49$$

2. Costs and Benefits of the Ariana and Polyculteur Packages Under Recommended Rates of Use (A).

a) The cost of the Ariana package under Alternative (A) is as follows:

$$\text{Cost of AR Package(A)} = \frac{\text{Cost of Oxen(A)} + \text{Cost of AR}}{7.5} + \text{Labor AR(A)} + \text{Fertilizer}$$

$$9{,}576 \text{ FCFA} = \frac{40{,}660 + 6{,}800}{7.5} + 2{,}400 + 848$$

The corresponding benefit is given by:

Benefit of AR Package		Output of peanuts/ha		Price of peanuts/kg		Output of Millet/ha		Price of Millet/kg		
29,764 FCFA	=	[(885	×	41.5)	+	(760	×	30)]	×	1/2

And the benefit cost ratio of the Ariana package under Alternative (A) is:

$$B/C\ [AR(A)] = \frac{29,764}{9,576} = 3.11$$

b) <u>The cost of the polyculture package under alternative (A) is:</u>

$$\text{Cost of POL Package(A)} = \frac{\text{Cost of Oxen(A)} + \text{Cost of POL}}{10.5} + \text{Labor POL(A)} + \text{Fertilizer}$$

$$\text{11,477 FCFA} + \frac{40,660 + 30,990}{10.5} + 2,285 + 2,368$$

The corresponding benefit is then given by:

Benefit of POL Package		Output/ha of peanuts		Price of Peanuts/kg		Output/ha of millet		Price of Millet		
43,188 FCFA	=	[(1,250	×	41.5)	+	(1,150	×	30)]	×	1/2

and the benefit/cost ratio by:

$$B/C\ [(POL(A)] = \frac{43,188}{11,477} = 3.76$$

3. Costs and Benefits of the Ariana and Polyculteur Packages Under Actual Rates of Use (B)

a) <u>The cost of the Ariana package under actual practices, i.e. under Alternative (B), gives us:</u>

$$\text{Cost of AR(B)} = \frac{\text{Cost of Oxen(B)} + \text{Cost of AR}}{3} + \text{Labor AR(B)} + \text{Fertilizer}$$

$$18{,}161 \text{ FCFA} = \frac{27{,}140 + 6{,}800}{3} + 6{,}000 + 848$$

Using the benefit of the AR package calculated in 2.a. above we get a benefit/cost ratio of:

$$B/C\ [(AR(B)] = \frac{29{,}764}{18{,}161} = 1.64$$

b) <u>The cost of the polyculture package under alternative (B) is as follows:</u>

$$\text{Cost of POL Package(B)} = \frac{\text{Cost of Oxen(B)} + \text{Cost of POL}}{4} + \text{Labor POL(B)} + \text{Fertilizer}$$

$$22{,}901 \text{ FCFA} = \frac{27{,}140 + 30{,}990}{4} + 6{,}000 + 2{,}368$$

Again using the benefit for the polyculture package calculated under 2b above we get a benefit cost ratio of:

$$B/C\ [(POL(B)] = \frac{43{,}188}{22{,}901} = 1.89$$

4. Cost and Benefits of the Ariana and Polyculteur Packages Under Theoretical Rates of Use (A) With 15 percent and 30 percent Adjustments for Labor Costs Respectively.

a) <u>The cost of the Ariana package under alternative A, with a 15 percent labor adjustment:</u>

$$\text{Cost of AR(C)} = \frac{\text{Cost of Oxen(A)} + \text{Cost of AR}}{7.5} + \text{Labor AR(C)} + \text{Fertilizer}$$

$$9{,}936 \text{ FCFA} = \frac{40{,}660 + 6{,}800}{7.5} + 2{,}760 + 848$$

This yields a benefit cost ratio of:

$$B/C\ [AR(C)] = \frac{29{,}764}{9{,}836} = 3.00$$

b) <u>The cost of the polyculteur package under alternative (A) with a 30 percent labor adjustment</u>:

$$\begin{matrix}\text{Cost of} \\ \text{POL(C)}\end{matrix} = \frac{\begin{matrix}\text{Cost of} \\ \text{Oxen(A)}\end{matrix} + \begin{matrix}\text{Cost of} \\ \text{POL}\end{matrix}}{10.5} + \begin{matrix}\text{Labor} \\ \text{POL(C)}\end{matrix} + \text{Fertilizer}$$

$$\begin{matrix}12{,}162 \\ \text{FCFA}\end{matrix} = \frac{40{,}660 + 30{,}990}{10.5} + 2{,}970 + 2{,}368$$

For the corresponding benefit/cost ratio we have:

$$B/C\ [POL(C)] = \frac{43{,}188}{12{,}162} = 3.55$$

F. Summary of Calculations

Table 11 gives a summary of these benefit/cost ratios for the three levels of technology under the alternative assumptions examined. Before discussing the results in the next section a few comments are in order.

The reader is cautioned that the data we have used in computing the B/C ratios are only approximate, particularily those concerning the cost of feeding the laborer, the salvage prices of some inputs, and the life of durable assets. The validity of the results of our computations and the conclusion stemming from them should be treated with appropriate caution. However, these results do suggest guidance for researchers investigating farmers' behavior towards new technology.

Obviously we have used the concept of benefit/cost ratio in a rather unconventional way in this analysis. Indeed, we have not discounted future steams of benefits and costs to a present value in order to compute the B/C ratios of each technological package. Rather, we have computed gross B/C ratios where all benefits and costs are included in the ratio, and where each is computed for an average year, rather than for the life of the investment. Moreover, since we are trying to explain farmer's behavior, investment costs in our computations relate to farmer's equity, not to social costs.

TABLE 11

SUMMARY OF BENEFIT/COST RATIOS FOR THREE LEVELS OF TECHNOLOGY UNDER ALTERNATIVE ASSUMPTIONS

Assumptions	Technology	B/C Ratios
All	Labor Package	3.49
(A) = Theoretical	Ariana Package	3.11
	Polyculteur Package	3.76
(B) = Actual	Ariana Package	1.64
	Polyculteur Package	1.89
(C) = Wage Adjustment	Ariana Package	3.00
	Polyculteur Package	3.55

VII. COMMENTS ON THE RESULTS

When we compare the B/C ratio of the labor package with those of the polyculteur and Ariana packages respectively under alternatives (A) and (C) we have the following:

B/C polyculteur package > B/C labor package > B/C Ariana package.

However, under alternative (B), the alternative which reflects what farmers actually do, we get a very different situation:

B/C labor package > B/C polyculteur package > B/C Ariana package.

These computations suggest that the technical packages which define the different levels of technical development in the old peanut basin are substantially less profitable than the labor package under actual farm conditions. This may explain why farmers, once equipped with one of these technical packages, are more likely to return to labor intensive methods than stay with capital intensive ones. This also explains the absence of any correlation between the equipment ratio and income, and the high correlation between income and the amount of land cultivated per rural active. In fact, according to our computations, the peasants find it more profitable to avoid intermediate technology as proposed to them by the extension boards.

The non profitability under farm conditions of these packages relative to the use of human labor is the basic reason for their limited adoption by farmers. Moreover, this situation will probably hold as long as the use of labor under farm conditions is more profitable. The tendency to overlook the cost of human labor within the household when computing the profitability of technical packages has led, as we have seen, to overestimating their profitability under actual farm conditions and has mislead research on impendiments to adoption.

Implications

The finding that the land extensive technology is more profitable than the intermediate technology embodied in the two technical packages has several implications. The first and most striking implication for the policy of rural development is that those who have the most important share of total peanut production (large farmers) and who have, consequently, the highest debt capacity (because credit is allocated in proportion to the quantity of peanuts marketed) do not find it profitable to contract a loan for technical packages. Rather, they are willing to take large loans for more seed and fertilizer so as to increase their revenue by using more human labor. This situation limits the ability of cooperatives to promote the adoption of new technology.

On the other hand, SODEVA has documented the tendency of large farmers in the peanut basin to contract loans for a pair of oxen for agricultural use, and after feeding and training them for two or three years, sell them to the butcher. This sale occurs just as the pair of oxen are strong enough to perform more and better agricultural labor. The price farmers receive for oxen obtained and worked this way are 3-4 times the purchase price. This practice is perfectly understandable when one considers that the technical packages with which the pair of oxen are used are not profitable relative to labor intensive alternatives. In other words, farmers are willing to use cooperative facilities to obtain credit for extensive agriculture, but loans intended for intermediate technology are diverted to other more profitable uses (feeding and reselling oxen). Moreover, peasants who own cattle are now rushing to be included in the program of <u>embouche bovine</u>, especially in Sine-Saloum. This confirms the Senegalese farmers' tendency to invest where it is profitable rather than where recommended by extension agents.

The fact that farmers are oriented towards using labor leads them to capitalize and to make savings not in cash, but in <u>grain</u>. The farmer will try to produce more millet, knowing that in this manner he will be able to hire more laborers and increase his cash income as needed. This may explain why large farmers who have a surplus of millet do not sell it in the market: they know that they will gain more by storing their surplus until next season in order to be able to purchase labor than by selling it after harvest.

Of course if the price of rice were less than the price of millet, farmers would certainly substitute rice for millet in the subsistence wage, pushing large quantities of millet into the market. But unless the relative prices between millet and rice favor such substitution in consumption, or unless the price of peanuts is relatively low with respect to millet--making and the land component of the wage for the laborer very cheap--the farmer will keep his millet to hire laborers for cultivating peanuts for cash.

Under current price ratios farmers will only sell their millet if they have special needs which they are not able to meet with incomes from their cash crop. This statement is consistent with the findings of Yaciuk and Yaciuk [1971] indicating that the number of farmers selling grains to the official marketing board during the official marketing period is far less than those who sell grain subsequently as needs for cash arise. Even in this situation, farmers sell millet only to meet these special needs. It would be misleading to interpret such selling as a move to the market or as a transformation of food crops into cash crops.

Thus, the unwillingness of farmers to sell millet should not be interpreted as a traditional, non market pattern of behavior. Those who think that farmers do not invest, or limit savings to security or survival needs, should find food for thought in the previous analysis. The notion of a subsistence economy where farmers produce food crops primarily to meet family requirements needs to be reconsidered. Furthermore, any attempt to make farmers produce food crops for the market will likely have limited success as long as farmers find it more profitable to use their grain for hiring labor to produce cash crops.

Moreover, the orientation of privileged farmers towards land extensive techniques requires the maintaining of a social structure which can reproduce labor cheaply. In other words, farmers--particularly the largest--will seek to maintain the traditional family structure, labor organization and land use patterns until price relationships change, making the shadow price of labor greater than alternative capital intensive technologies. This explains the survival of the traditional family structure and its reproduction in the areas of new settlement.

APPENDICES

APPENDIX 1

Complete Annual Budget for Oxen Kept Five Years (A)

Items / Years	1	2	3	4	5	6	7	8	9	10	Average
Loan Repayment[1]	10,000	10,000	10,000	10,000	10,000	9,000	9,000	9,000	9,000	9,000	----
Equipment Depreciation[2]	500	500	500	500	500	500	500	500	500	500	500
Oxen Depreciation[3]	-29,000	-29,000	-29,000	-29,000	-29,000	-29,000	-29,000	-29,000	-29,000	-29,000	-29,000
Cumulative Investment[4]	38,500	77,000	115,500	154,000	192,500	40,000	77,500	115,000	152,500	190,000	----
Salvage Value	----	----	----	----	190,000	----	----	----	----	190,000	----
Average Cumulative Investment[5]	19,250	57,750	96,250	134,750	173,250	21,250	58,750	96,250	133,750	171,250	96,250
Opportunity Cost of Average Cumulative Investment (15%)	----	----	----	----	----	----	----	----	----	----	14,438
Feed:	----	----	----	----	----	----	----	----	----	----	28,800
Peanut Hay Grain Supplement	----	----	----	----	----	----	----	----	----	----	21,600
Repairs	----	----	----	----	----	1,000	1,000	1,000	1,000	1,000	500
Working Capital[6]	----	----	----	----	----	----	----	----	----	----	25,450
Opportunity Cost of Working Capital (15%)	----	----	----	----	----	----	----	----	----	----	3,818

[1] Acquisition price of oxen is 45,000 FCFA and for equipment 5,000 FCFA. The loan is repaid in 5 equal annual installments at the end of the cropping year. In year 6 the farmer secures a second pair of oxen only.

[2] Assuming straight line depreciation with zero salvage value.

[3] Actually an appreciation since oxen increase rather than decrease in value.

[4] Undepreciated loan repayment plus oxen appreciation.

[5] Average of the beginning and ending year cumulative investment.

[6] Assuming straight line accumulation over the year to cover cost of feed and repairs with repayment from cropping activities at the end of each year.

APPENDIX 2

Complete Annual Budget for Oxen Kept Three Years (B)

Items \ Years	1	2	3	4	5	6	7	8	9	10	Average
Loan Repayment[1]	10,000	10,000	10,000	10,000 9,000	10,000 9,000	9,000	9,000 9,000	9,000 9,000	9,000	13,000	----
Equipment Depreciation[2]	500	500	500	500	500	500	500	500	500	500	500
Oxen Depreciation[3]	-38,333	-38,333	-38,333	-38,333	-38,333	-38,333	-38,333	-38,333	-38,333	-38,333	-38,333[7]
Cumulative Investment[4]	47,833	95,666	143,500	40,333	97,166	144,000	39,333	95,666	142,500	----	----
Salvage Value	----	----	160,000	----	----	160,000	----	----	160,000	----	----
Average Cumulative Investment[5]	23,917	71,750	119,583	11,917	68,750	120,583	11,917	67,750	119,083	----	68,361[7]
Opportunity Cost of Average Cumulative Investment (15%)	----	----	----	----	----	----	----	----	----	----	10,254
Feed: Peanut Hay Grand Supplement	----	----	----	----	----	----	----	----	----	----	28,800 21,600
Repairs	----	----	----	----	----	1,000	1,000	1,000	1,000	1,000	500
Working Capital[6]	----	----	----	----	----	----	----	----	----	----	24,450
Opportunity Cost of Working Capital (15%)	----	----	----	----	----	----	----	----	----	----	3,818

[1]Acquisition price of oxen is 45,000 FCFA and for equipment 5,000 FCFA. The loan is paid in 5 equal annual installments at the end of the cropping year. In years 4 and 7 the farmer secures new loans for a second and third pair of oxen only and repays all outstanding debts in year 10.

[2]Assuming straight line depreciation with zero salvage value.

[3]Actually an appreciation since oxen increase rather than decrease in value.

[4]Undepreciated loan repayment plus oxen appreciation.

[5]Average of beginning and ending year cumulative investment.

[6]Assuming straight line accumulation over the year to cover cost of feed and repairs with repayment from cropping activities at the end of each year.

[7]Actually 9 years average since complete oxen cycle is 3 years and 3 complete cycles cover 9 years.

APPENDIX 3

Complete Budget for Polyculteur

Items / Years	1	2	3	4	5	6	7	8	9	10	Average
Loan Repayment[1]	42,255	42,255	42,255	42,255	42,255	----	----	----	----	----	----
Equipment Depreciation[2]	18,127	18,127	18,127	18,127	18,127	18,127	18,127	18,127	18,127	18,127	18,127
Cumulative Investment[3]	24,128	48,256	72,384	96,512	120,640	102,513	84,386	66,259	48,132	30,000	----
Salvage Value	----	----	----	----	----	----	----	----	----	30,000	----
Average Cumulative Investment[4]	12,064	36,192	60,320	84,448	108,576	111,577	93,450	75,323	57,195	39,066	67,821
Opportunity Cost of Average Cumulative Investment (15%)	----	----	----	----	----	----	----	----	----	----	10,173
Repairs	----	----	----	----	----	5,000	5,000	5,000	5,000	5,000	2,500
Working Capital[5]	----	----	----	----	----	----	----	----	----	----	1,250
Opportunity Cost of Working Capital (15%)	----	----	----	----	----	----	----	----	----	----	188

[1]Acquisition price of polyculteur is 211,275 FCFA. The loan is repaid in 5 equal installments at the end of the cropping year.

[2]Assuming straight line depreciation and a salvage value of 30,000 FCFA at the end of the year 10.

[3]Undepreciated loan repayment.

[4]Average of the beginning and ending year cumulative investment.

[5]Assuming straight line accumulation over the year to cover the costs of repairs with repayment from cropping activities at the end of each year.

APPENDIX 4

Complete Budget for Ariana

Items / Years	1	2	3	4	5	6	7	8	9	10	Average
Loan Repayment[1]	9,828	9,828	9,828	9,828	9,828	----	----	----	----	----	----
Equipment Depreciation[2]	4,464	4,464	4,464	4,464	4,464	4,464	4,464	4,464	4,464	4,464	4,464
Cumulative Investment[3]	5,364	10,728	16,092	21,456	26,820	22,356	17,892	13,428	8,964	4,500	----
Salvage Value	----	----	----	----	----	----	----	----	----	4,500	----
Average Cumulative Investment[4]	2,682	8,046	13,412	18,776	24,138	24,588	20,124	15,660	11,196	6,732	14,535
Opportunity Cost of Average Cumulative Investment (15%)	----	----	----	----	----	----	----	----	----	----	2,180
Repairs	----	----	----	----	----	300	300	300	300	300	150
Working Capital[5]	----	----	----	----	----	----	----	----	----	----	75
Opportunity Cost of Working Capital (15%)	----	----	----	----	----	----	----	----	----	----	11

[1]Acquisition price of Ariana is 49,140 FCFA. The loan is paid at the end of the cropping year in five equal installments.

[2]Assuming straight line depreciation and a salvage value of 4,500 FCFA at the end of year 10.

[3]Undepreciated loan repayment.

[4]Average of beginning and ending year cumulative investment.

[5]Assuming straight line accumulation over the year to cover the cost of repairs with repayment from cropping activities at the end of each year.

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